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ABSTRACT

This report is based on the record of three Congressional subcommittee hearings that examined: how the principles of total quality management can be used to improve schools; how companies can work with schools to assure that new workers are able to perform in a total quality environment in the workplace; and how modern computer-based educational technologies can aid in assuring that graduates of the nation's high schools are educated and possess the technological literacy required of careers they seek. After a background section on the subcommittee's scope of interest, summaries of the testimonies given by witnesses at the hearings on quality in education and total quality management techniques are provided. Findings and conclusions reported include that: (1) principles of total quality management can be adopted for application within education; (2) computer-based instruction used in business can be a model for schools seeking to increase the use of technology; (3) schools are not adequately preparing students for the workplace; (4) lack of requisite mathematics, science, and literacy skills in the workplace is a deterrent to implementing total quality management in a firm; and (5) employee training in skills unique to the firm is a necessary component of total quality management. Five recommendations involving the interrelationship between schools, business, and the Federal Government are made. (MDH)

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[COMMITTEE PRINT]

QUALITY IN EDUCATION

REPORT

PREPARED BY THE

SUBCOMMITTEE ON
TECHNOLOGY AND COMPETITIVENESS

TRANSMITTED TO THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED SECOND CONGRESS

SECOND SESSION

Serial P

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LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, DC, June 30, 1992.

Members of the Committee on Science, Space, and Technology:

DEAR COLLEAGUES: I transmit for your attention a report on quality and education by the Subcommittee on Technology and Competitiveness prepared at the direction of Subcommittee Chairman Tim Valentine. The report was circulated to the Members of the Subcommittee for review and revised in light of the comments received. The revised report was approved by the Subcommittee by voice vote on June 24, 1992. Members of the Subcommittee were given three days to file separate remarks. None were received.

The report is based upon the record of three hearings held by the Subcommittee which examined the application of total quality principles to education and examined issues involved in the application of computer technologies to learning in K–12 classrooms. The report reviews the Subcommittee's involvement with total quality management, summarizes the hearings, and makes findings and recommendations concerning quality, technology, and the nation's schools.

The American education system does not produce graduates that are trained, educated, and scientifically literate. They do not test to international standards. This failure has been cited repeatedly by witnesses in our hearings as one of the key factors affecting the competitiveness of American industry. I commend the Subcommittee's report to your attention.

Sincerely,

GEORGE E. BROWN, Jr., *Chairman.*

LETTER OF SUBMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, DC, June 29, 1992.

Hon. GEORGE E. BROWN, Jr.,
Chairman, Committee on Science, Space, and Technology,
U.S. House of Representatives

DEAR MR. CHAIRMAN: I submit herewith a report on how the principles of total quality management can be applied to improve the nation's schools, and how modern, computer-based educational technologies can aid in this process. The report was prepared under my direction by the staff of the Subcommittee.

The report is based upon the record of three hearings held by the Subcommittee which examined how the principles of total quality management can be used to improve schools, how companies can work with schools to assure that new workers are able to perform in a total quality environment in the workplace, and how modern computer-based educational technologies can aid in assuring that graduates of the nation's high schools are educated and possess the technological literacy required of careers they seek.

The report reviews the Subcommittee's involvement with total quality management, summarizes the hearings, and makes findings and recommendations concerning quality, technology, and the nation's schools.

Cordially,

TIM VALENTINE, *Chairman,*
Subcommittee on Technology and Competitiveness.

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I. Introduction

This report is based upon the record of three hearings held by the Subcommittee which relate to topics in quality and education and to using new technologies in K-12 classrooms.

—Quality Improvement in America, April 23, 1991

—Educational Technology: Computer-Based Instruction, June 18, 1991

—Quality Improvement in Small and Mid-Sized Manufacturers, February 5, 1992

At the first of these hearings, the Subcommittee received testimony from the 1990 winners of the Malcolm Baldrige National Quality Award and from leaders in the field of education on their views of how the principles of total quality management can be used to improve the nation's schools. How companies, dedicated to total quality management, can work with the schools to assure that new workers are able to perform in a total quality environment was also examined. The second hearing focused on the opportunities modern, computer-based educational technologies provide for improved, individualized instruction. The third hearing included testimony from the 1991 Baldrige Award winners and focused on how small businesses can become world-class businesses. The need for a literate workforce with math skills was cited by the award winners as critical to implementing total quality management. This report reviews the Subcommittee's involvement with total quality management, summarizes the hearings, and makes findings and recommendations concerning quality, technology, and the nation's schools.

II. Background

The Subcommittee on Technology and Competitiveness and its predecessor the Subcommittee on Science, Research, and Technology have a long-standing interest in total quality management. After extensive oversight activities related to quality in 1985 and 1986 including a field visit to review Florida Power and Light's quality program, the Subcommittee became convinced that it would be in our national interest to create a U.S. award, analogous to Japan's Deming Award, honoring the U.S. based manufacturers, service companies, and small businesses which come the closest to achieving total quality management. Legislation to create a U.S. national quality award was introduced by Committee Chairman Don Fuqua in 1986 and reintroduced by Subcommittee Chairman Doug Walgren in 1987. The legislation passed the House and after the Secretary of Commerce's untimely death was renamed the Malcolm Baldrige National Quality Improvement Act of 1987. It then became law. The Act establishes the Malcolm Baldrige National

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Quality Award, recognizes quality achievements of U.S. companies and publicizes successful quality strategies.

The Malcolm Baldrige National Quality Award is now offered annually to American companies that demonstrate the highest level of total quality management. Companies applying for the award must undergo a rigorous evaluation procedure, including expert review of a detailed application, followed by site visits. Funding for the program comes from application fees and from the private Foundation for the Malcolm Baldrige Award. Winners may publicize their awards provided they agree to share information about their successful quality strategies with other companies.

The Subcommittee has carefully monitored the progress of the Malcolm Baldrige National Quality Award Program and annually has held hearings honoring the award winners. At each of these hearings, the Subcommittee has focused on a current topic of importance related to quality.

The Subcommittee's 1991 theme was the relationship between total quality management and education. This relationship has many aspects. Total quality management is a natural for inclusion in elementary and secondary mathematics curricula including the general math curriculum which trains high school graduates who directly enter the workforce. These workers must understand the elements of statistics, data gathering, and data analysis to function in a total quality environment. These skills are largely arithmetic-based.

The Subcommittee in these hearings explored the extent to which total quality management principles can apply to schools. As with businesses, the Subcommittee assumed that successful quality programs in schools require commitment and involvement of the most senior management to quality principles and the implementation of the quality program. Successful quality programs provide all employees with the freedom to contribute to achieving common goals. They function best when they have clearly stated goals, they measure progress as they constantly try to improve in reaching their goals, and the organization is striving to meet the demands of its customers and work with its suppliers on jointly improving quality. One key customer group for schools are those who take the output of the schools. For a typical high school, this would be colleges, the armed services, and local employers. A high school implementing total quality management presumably would monitor the progress of its graduates periodically and would survey colleges, the military, and employers to find out the strengths and weaknesses of its graduates. This information would be fed back into the school's planning process and appropriate curriculum and other adjustments would be made. Similarly, just as businesses work with their suppliers of raw materials in making clear what is expected, schools contemplating quality programs could work with the lower schools and the families which supply the students to make sure that students that matriculate are ready to take advantage of the school's opportunities.

Modern equipment operated by properly trained personnel also holds great promise for rapid improvement in the ability of schools to produce graduates who are able to meet the demands of the modern workplace. For over a quarter century now, it has been

recognized that the computer is a key to a vastly improved educational process. In the computer based system, the educator has the opportunity to work with each student in a more personalized relationship and has more time to supervise students working together with their peers.

Computers have been slow to reach their potential in the classroom. Twenty-five years ago, computer-based learning systems failed because the technology available was not up to the task. But in the intervening years, critical advancements in computer speed and storage capacities, speech synthesis, and inexpensive broadband communications systems now provide some of the key technologies required for an effective system. Furthermore, most American youth are now comfortable with the computer terminal. If total quality management principles penetrate the nation's schools, increased use of these technologies will probably follow. If the schools become dedicated to continuous improvement and to meeting the needs of increasingly computerized employers, the frequency of use of advanced technology in education will increase naturally.

The Subcommittee's quality theme for its 1992 hearings was quality in small and medium-sized businesses. Since all three 1991 winners of the Malcolm Baldrige were small and medium-sized companies, the Subcommittee was interested in understanding how these and other smaller companies with limited resources have been able to reach the state of the art in business practices. Other witnesses at that hearing were from organizations that provide worker training and consulting services in quality improvement techniques to smaller businesses.

III. Witnesses

The witnesses at the hearing on April 23, 1991 represented educators at the secondary and university level, and representatives of national educational organizations. The witnesses at the hearing on June 18, 1991 represented Federal agencies concerned with the application of technology to learning, educators, and specialists in the application of computer technologies. Their testimony is summarized in Section A. The testimony of the Malcolm Baldrige award winners and others involved in total quality management techniques is summarized in Section B.

A. Quality in Education

Frank Huband, Executive Director, American Society for Engineering Education, proposed extending the Malcolm Baldrige Quality Award concept to education. He noted that of the students who begin higher engineering education, 35 percent do not graduate. This number is significantly higher for minority groups. To address this issue, and the overall issue of quality in engineering education, he recommends creating a total quality management program for engineering schools accompanied by a government-sponsored award for quality.

Dr. Iris Carl, President, National Council of Teachers of Mathematics (NCTM) reported on the development by that organization of curriculum and evaluation standards for school mathematics.

Council members were concerned by statistics that show that, of 3.5 million children who enter school in the U.S., one-third are slow-tracked. This early sorting and negative tracking produces drop-outs. The Council believes schools should be in the business of praising and rewarding excellence. To achieve this, the Council has created a curriculum standard for the teaching of mathematics, based in part on total quality management techniques, to ensure academic competence in mathematics.

Edward McClosky, Director of Human Resources, Lehigh University, focused his comments on the application of total quality management techniques to education. He said that the media has recently begun criticizing education for failing to produce graduates that are able to help American companies compete successfully. In response, Lehigh has instituted a resource management program to reexamine university functions for their relevance to the university's central teaching mission. As a result, more control over operations was put in the hands of departments, and the role of non-teaching units is being rethought. McClosky pointed out that institutions that do not practice quality control cannot adequately teach the concepts. McClosky said that a quality award for education that rewards those schools that provide essential services with appropriate costs would establish a national standard to which educational institutions could aspire.

Dr. Walter Massey, Director of the National Science Foundation (NSF), testified that trained, educated, and scientifically literate people are the major resource of any modern society, yet U.S. students are not testing to international standards. We must put new technology to work improving our education system. The NSF has taken the lead in developing some of this technology, but the dissemination to schools has not been completely successful. North Carolina's SuperQuest program is a good example of ways to get students excited about computing. In addition, the U.S. must work to get the business community involved in the process of educating students about computers.

David Kearns, Deputy Secretary of the Department of Education, emphasized that the application of technology to learning must be applied in the context of understanding how children learn. Within this context, the U.S. Department of Education continues to fund research on active learning. At the same time, the Department of Education funds a number of innovative program to encourage the application of technology to learning. Among these are the Fund for Innovation in Education, programs to aid disabled students, and technology targeted toward very young learners. Contributions by business firms are encouraged through the Small Business Innovation Research (SBIR) program. A National Diffusion Network has helped disseminate new technology, as has the Education Resources Information Center. The Administration is proposing the "America 2000" program to reinvigorate American schools, with a view towards introducing new technologies into pedagogy.

Dr. Linda Roberts, Senior Associate, Science, Education, and Transportation Program, Office of Technology Assessment, said that technology is a tool of teaching rather than a solution to education's problems. But, technology is only effective in the hands of well-trained, enthusiastic teachers; development of new software

applications are crucial; and educational technology needs help to keep up with advancing technology in the computer field. A federal policy could address these factors, allow schools to acquire the technology they need, support teacher development, and build research into practice.

Ronald Fortune, President, Computer Curriculum Corporation of California, discussed the state of computer-based instruction (CBI) technology. The three main areas where CBI growth should focus are: (1) multimedia technology combining speech, pictures, and sound; (2) pen-driven technology allowing the use on computers of handwritten notes; and (3) artificial intelligence to create the intelligent computer-tutor. Fortune offers four recommendations: (1) ensure at least six workstations per classroom per school; (2) each school should have specialized workstations for math and science; (3) sponsor a Federal interdepartmental CBI effort; and (4) support adequate education funding.

Albert Shanker, President, American Federation of Teachers, said that the U.S. needs a system of incentives to encourage excellence in education, and within that, to encourage the use of technology. These incentives should not be legislated or mandated, but should be seen as an integrated approach to solutions to educational problems.

Dr. Leroy Tuscher, Professor of Education and Computer Science, Lehigh University, cited three factors for increased applications of new technology: (1) heavy capital investment; (2) improved management techniques; and (3) technology itself. Teaching consists of three functions: (1) delivery of classroom materials; (2) managing the mix of learning resources; and (3) production of final product. These functions remain constant, but teacher time can be redistributed. Changes in classroom resources will require investment, retraining of teachers, and smarter software systems.

Dr. Thomas Houlihan, Superintendent, Johnson County Schools, Smithfield, North Carolina, testified that there are three primary reasons for the disparity between the availability of technology for learning and its use in education: (1) the cost of the technology is often prohibitive; (2) the American system of education is still in a post-World War II mode of operation; and (3) the software available is of questionable value. Education in America is vastly underfunded. The tax dollars available go to fund basic infrastructure needs, and expensive technology is not a funding priority. The organization of schools has not changed in 40 years, and technology is not viewed as important and is not understood by educators. In the development of software, little attention is given to its correlation with curriculum or theory-based instructional techniques. Dr. Houlihan testified that in his school system, the use of computer technology has dramatically improved student achievement. Use of computer technologies responds to the visual stimulation that today's students receive from TV, video-discs and camcorders. His school district has also documented achievement from students labeled "at risk." In one school, students achieved a 57 percent gain in reading after a computer-based learning system was installed. Three years after the computer learning system was installed, the school was selected as a U.S. Department of Education "National School of Excellence."

Jeffrey Joseph, Vice President for Domestic Policy, U.S. Chamber of Commerce, noted that technology is rapidly changing virtually every aspect of the way Americans work and live. The value of unskilled labor is rapidly disappearing. Employees on the factory floor must be literate and skilled in mathematics and computers. Businesses, particularly high technology businesses, spend 30 percent of their training budgets on computer-based education. This can serve as a model for schools. Very little data exists about the training needs of small businesses. He recommends a special tax write-off to allow businesses to give computers to schools.

B. QUALITY IN SMALL AND MEDIUM SIZE BUSINESS

Dr. Curt Reimann, Director of Quality Programs at the National Institute of Standards and Technology, cited three factors common to small and medium size businesses where quality plays an important role in determining success or failure of the business: (1) they compete in tough, quality-sensitive markets; (2) many are suppliers to companies that compete in the toughest international markets, and some of the largest companies have narrowed their supplier base by 50–90 percent due to increasingly stringent quality requirements; and (3) new opportunities associated with the changing international trade picture are attractive to many small and medium size firms.

A number of key trends and grassroots efforts signal a greater action to improve quality in all business sectors. There has been a tremendous upsurge in business school and other academic interest in total quality management. State quality efforts continue to expand. And, the media is now addressing quality and related competitiveness issues.

Mr. Koe Nishimura, of Solectron, the first of the 1992 Baldrige Award winners, testified that his company's policy is to put the customer first by providing outstanding quality, delivery, schedules, and service. The company keeps costs down by empowering employees through focused training. The company's employees are its most important asset. Other necessary conditions for success include implementation of key technologies required to provide competitive products and services, and practicing continuous improvement. Financial tools such as an R&D tax credit will help encourage further investment in the technologies needed to stay competitive.

Mr. Ronald D. Schmidt of Zytec Corporation, the second Baldrige Award winner for 1992, testified about the various strategies it implemented to achieve excellence. They include implementation of Statistical Process Control (SPC), just-in-time manufacturing, a total quality commitment to satisfying the customer, training classes for all employees, adoption of a methodology of planning whereby all employees develop objectives and measure progress toward them, using the Baldrige Award criteria to further improve the company, and empowering employees to spend company money to solve customer problems.

Raymond Marlow, of Marlow Industries, the third 1992 Baldrige Award winner, testified that in 1988, when the company first saw the Baldrige Award criteria, it restructured its whole operation to

comply with the Baldrige requirements. As a result, the company's customers are happy and the company's employees realize the value of staying in close customer contact. The employees are also happy because they have been empowered through training to work together on problems solving.

The award winners were asked how important the quality process is to their competitiveness compared to other important factors such as tax and trade policy. All three winners ranked the quality process as the most important.

The winners were also asked what further actions Congress could take to promote quality. Mr. Nishimura stated that workforce training was important, and it would be useful if the government could create incentives to train the workforce. Mr. Nishimura testified that Solectron has contracted with a local community college to teach English as a second language to many in his workforce. Also, the company has made available a vice president for resource development to work with a committee of the local school district to make sure the K-12 curriculum meets workforce needs. Solectron devotes about one percent of its revenues to training. This currently amounts to two and half million dollars. Mr. Nishimura testified that this will be a continuous commitment on the part of Solectron because the investment pays off.

Mr. A. Blanton Godfrey, Chairman and CEO of the Juran Institute, a research and education organization providing training and consulting services relative to quality management, reinforced Mr. Nishimura's testimony about the importance of education and training of the workforce as the most important factor in restoring the competitiveness of American industry. He testified that our Achilles heel is our educational system. Too many firms are having to provide basic education to their employees, when they should be training them to do the things that are special and unique about their companies. The burden should be shifted back to our education system, both K-12 and university level.

D. Wayne Peterson of North Carolina Telephone, a recipient of the North Carolina Quality Leadership Award, similar to the Baldrige Award at the state level, concurred with some of the themes of Mr. Godfrey's testimony. He stated that American companies could solve their quality problems if they were willing to solve the "people problems" by investing in total quality training and then empowering employees to apply it. North Carolina Telephone also spends about one percent of its revenues, or about $5.2 million, on education and training.

Mr. Tony Tlush of the Manufacturing Services Extension Center in Bethlehem, Pennsylvania, which provides consultant services in total quality management practices to small and medium-size manufacturers, testified that one of the most common deterrents to implementing total quality management in a firm is the marginal math and literacy skills within the workforce. The increasing gap between the technology of modern manufacturing and available worker skills is choking the manufacturer. While training is available, basic educational skills development is a cost that no business should have to incur. Mr. Tlush agreed with Mr. Godfrey that making sure that the American worker has basic educational skills is the responsibility of the educational system. Mr. Tlush testified

that we need to develop a national quality implementation strategy to address education standards that stress math, science, and literacy. Firms also need to implement internal quality education training and apprenticeship programs.

IV. Findings and Conclusions

1. The principles of total quality management can be adopted for application within education. This is true for education as a whole and at various educational levels.
2. Computer-based instruction now being used in business can act as a model for schools seeking to increase the use of new technology in the schools.
3. Making sure American students achieve basic educational skills development is the responsibility of the educational system, and schools are not preparing their graduates adequately for the workforce. As a result, large corporations spend a considerable amount of money and attention upgrading the basic math and reading skills of their employees when they should be spending the money on giving their employees additional skills necessary for success in the business.
4. The lack of requisite math, science, and literacy skills in the workforce is one of the most common deterrents to implementing total quality management in a firm. Employees on the factory floor must know how to apply statistical techniques to the manufacturing process, and often must have a knowledge of computer applications.
5. Training employees to give them skills unique to the success of the firm and empowering them to become part of the decision-making process cuts costs and promotes productivity and efficiency, and is a necessary component of total quality management.

V. Recommendations

1. The Department of Education should examine increasing applications of quality principles at all stages of the education process.
2. Educators at all level should become more responsive to business's needs for literate students with good basic mathematics skills, and should work with community business leaders to determine standards for a quality education.
3. The Federal Government should seek ways to aid educators in establishing links with businesses, the military, and colleges to determine the level of preparedness needed for the next stage of life, and to survey how well graduates are fairing in these institutions.
4. The Federal Government should institute an award for educational quality, or the application of quality principles to education, similar to the Malcolm Baldrige Award. This should include recommendations to ensure interdisciplinary education within the school, and to ensure that inputs to the educational process are of high quality.
5. Managers in business must recognize the importance of education and training in developing total quality management and devote sufficient and continuing resources to education and training.

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